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ELECTRODE GLOW DURING ELECTROLYSIS

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During experiments on electrolysis (Palit1963, 1967) we have often observed a remarkable phenomenon, and since we have been unable to find any mention of this in the literature, we report here the same.

The phenomenon in question is a glow of an electrode accompanying electrolysis. The glow is very easily produced on electrolysis with platinum wire electrodes in a simple *U*-tube or in an apparatus as shown in Fig. 1. On filling the

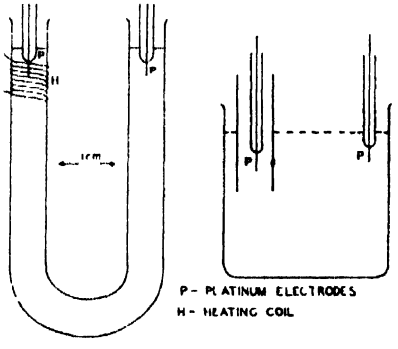

Fig. 1.

apparatus with an electrolyte solution of about 0.2N concentration and applying 220 volts D.C. (mains) a current of a few hundred milliamperes which increases with time, passes. In a short while (a few seconds to a few minutes) the current sharply drops to a lower value with slight fluctuations and one of the electrodes starts glowing brightly. This beautiful glow appears to be predominantly 'white' when viewed through an ordinary prism. The onset of glow is accompanied by formation of big bubbles on the electrode surface. Sometimes when the conditions are not quite right, these two characteristic changes (sharp drop in current strength and formation of big bubbles on the electrode) set in, but no glow is visible.

This kind of glow appears on the cathode with many electrolytes; for example, sodium chloride, sodium nitrate, potassium chloride, potassium nitrate, barium chloride, strontium chloride, calcium chloride, hydrochloric acid, nitric acid, etc. Some electrolytes show anode glow, typical examples being sodium hydroxide, sulphuric acid and many sulphates at suitable concentrations. Chlorides do not show anode glow but some nitrates under suitable conditions do. Sodium hy-

droxide, however, shows both kinds of glow, anode glow being favoured at high concentration and cathode glow at a lower concentration. The glow (cathode) is very spectacular with barium chloride and strontium chloride solutions appearing like beautiful deep violet glow with a flame-like halo.

The factors which influence the glow are (i) nature of the electrolyte, (ii) concentration of the electroyte, (iii) size of the electrode (iv) electrode material, (v) shape of the vessel, (vi) current density and voltage, and (vii) temperature of the electrolyte, the last factor being by far the most important. Externally heating the apparatus hastens the onset of glow so much so that if one of the electrode chambers is preheated to almost boiling by sending a regulated current through an external heating coil, the glow appears much sooner, almost as soon as the current is switched on under favourable conditions.

The following tentative explanation is offered. The cathode glow is due to the catalysed combination of hydrogen atoms (solvated or unsolvated) on the platinum surface of the electrode, *i.e.*, $H+H \rightarrow H_2$ takes place on the electrode. The narrow shape of the glowing cell not only helps to raise the local temperature but also helps to build up the local H concentration to a high enough value by preventing them from diffusing out. The anode glow is due to recombination of OH radicals to form oxygen.

If sparking and arcing are not considered, we could find reported in the literature at least two phenomena similar to the present electrode glow. One is the so-called "anode effect", i.e. a multi-star anode glow sometimes observed in the electrolysis of molten electrolytes (Mantell 1960). Another is the glow-discharge electrolysis particularly contact glow-discharge electrolysis reviewed by Hickling (1964), except that these discharges have been reported to occur at the anode and to need much higher voltage (500 volts and up). Detailed results will be published later.

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REFERENCES

Hickling, A., 1964, *The Encyclopedia of Electrochemistry edited by C. A. Hampel* Reinhold Publishing Corporation P. 632.

Mantell, C. L., 1960, *Electrochemical Engineering*, McGraw-Hill, P. 359, 369.

Palit, S. R., 1963, *Electrochemistry, Proceedings of the First Australian Conference on Electrochemistry, editors : J. A. Friend and F. Gutman*, Pergamon Press, P. 711.

———, 1967, *Indian, J. Phys.* 41, 309.